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Earning Animals

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disseminate knowledge

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Dedicated to

Our Parents and Teachers

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PREFACE

This book on “Earning Animals” is written with a view to highlight the importance of some invertebrate and vertebrate species used for earning both at individual and national levels.

It aims at creating awareness among students, entrepreneurs and unemployed youth for gainful employment. The candidate species selected are some useful annelids, arthropods, unio, fish and mammals. A chapter on aquaponics- a method of cultivation of fish and plant farming devoid of soil has also been described.

Since most of these animal species are included in the syllabi of Indian Universities and colleges, we believe this book will be helpful to the students to meet their curricular requirements.

While preparing the manuscript, we took the help of many friends and well wishers. To name a few, we are gratefully acknowledge the help and encouragement received from Prof. A. K. Panda; principal, Jatni College, Jatni; prof. U.R. Acharya; Prof. R.C. Choudhury; Dr. T.K. Barik; Prof. S. K. Das; Dr. S Sangeeta and Dr. S. K. Panigrahi. We also thank Dr. A. K. Rath, Dr. N. Panda, Dr. S.R. Mohanty, Dr. R. K. Mohapatra, Smt. Sunita Sarangi and Sri N. Mohanty.

There might be errors due to oversight, we will gladly take care to correct them if pointed out by the readers of the book.

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EARTHWORM –VERMICOMPOSTING

Classification

Phylum:Annelida;Class: Oligochaeta; Order: Opisthopora; Genus: *Eisenia*; Species: *foetida*

Introduction

Deep beneath the earth, they thrive — pink, slimy and insatiably hungry. They are with us all the time, rooting through our gardens, digging through our lawns and consuming everything in their path. Aristotle called them the intestines of the -world. The ancient Chinese called them angels of the soil. Angels or intestines, worms are a tiny but formidable force, eating their way through organic matter and leaving a trail of rich humus in their wake. Vermicomposting is the practice of using worms to turn the organic waste into nutrient-rich fertilizer. In recent years efforts have been made to use the potentiality of earthworms in recycling nutrients, waste management and development of vermicomposting systems at commercial scale. These are also called as "Ecosystem engineers" as they increase the numbers and types of microbes in the soil by creating conditions under which these creatures can thrive and multiply. In India, the integration of crops and livestock and use of manure as fertilizer were traditionally the basis of farming systems. But development of chemical fertilizer industry during the green revolution period created opportunities for low-cost supply of plant nutrients in inorganic forms which lead to rapid displacement of organic manures derived from livestock excreta. The deterioration of soil fertility through loss of nutrients and organic matter, erosion and salinity, and pollution of environment are the negative consequences of modern agricultural practices. In India, millions of tons of livestock excreta are produced annually. Odour and pollution problems are of concern. Currently the fertilizer values of animal dung are not being fully utilized resulting in loss of potential nutrients returning to agricultural systems. The potential benefits of vermicomposting of livestock excreta, municipal solid wastes such as kitchen wastes, market wastes, garden wastes, include control of pollution and production of a value- added product. Vermicomposting of different livestock excreta including cattle dung; horse waste; pig waste; goat waste; sheep waste; turkey waste and poultry droppings has been reported.

Organic wastes can be ingested by earthworms and egested as a peat-like material termed "vermicompost". Recycling of wastes through vermicomposting reduces the problem of non-utilization of livestock excreta. During vermicomposting, the important plant nutrients such as

N, P, K and Ca present in the organic waste are released and converted into forms that are more soluble and available to plants.

Potential benefits of Vermicomposting

Vermicompost appears to be generally superior to conventionally produced compost in a number of important ways;

- Vermicompost is superior to most composts as an inoculant in the production of compost.
- Worms have a number of other possible uses on farms, including value as a high quality animal feeds. Vermicompost also contains biologically active substances such as plant growth regulators. Moreover, the worms themselves provide a protein source for animal feed.
- Vermicomposting and vermiculture offer potential to organic farmers as sources of supplemental income.

Vermicompost has the following advantages over chemical fertilizers.

- It restores microbial population which includes nitrogen fixers, phosphate solubilizers etc.
- Provides major and micro- nutrients to the plants. Improves soil texture and water holding capacity of the soil.
- Provides good aeration to soil, thereby improving root growth and proliferation of beneficial soil microorganisms.
- Decreases the use of pesticides for controlling plant pathogens. Improves structural stability of the soil, thereby preventing soil erosion.
- Enhances the quality of grains/ fruits due to increased sugar.
- Reduces heavy metal pollution by decreasing the metal content in municipal solid wastes (as earthworms absorb all toxic materials like heavy metals such as Hg, Pb, Zn, Cd in their body tissue by vermicomposting).
- At the same time, the beginning of vermicomposting process is a more complicated process than traditional composting:
- It can be quicker, but to make it so generally requires more labour.
- It requires more space because worms are surface feeders and won't operate in material more than a meter in depth.
- It is more vulnerable to environmental pressures, such as temperature, freezing conditions and drought.
- Vermicomposting Technology for Recycling of Organic Wastes.

Methods

In general, there are two methods of vermicomposting under field conditions.

1. Vermicomposting of wastes in field pits.
2. Vermicomposting of wastes on ground heaps

Vermicomposting of Wastes in Field Pits

It is preferable to go for optimum sized ground pits of 20 feet length 3 feet width 2 feet deep for effective vermicomposting bed.Series of such beds are to be prepared at one place.

Vermicomposting of wastes on Ground Heaps

Instead of open pits, vermicomposting can be taken up in ground heaps. Dome shaped beds (with organic wastes) are prepared and vermicomposting is taken up.Optimum size of ground heaps may be 10 feet length x 3 feet width x 2 feet high.

Materials Required for Vermicomposting

- Kitchen wastes, MSW (Municipal solid wastes such as market wastes, hotel wastes), garden wastes, farm wastes etc.
- Fresh cow dung.
- Wastes: dung ratio (1:1 on dry weight basis).
- Earthworm: 1000-1200 adult worms (about 1 kg per quintal of waste material).
- Water: 3-5 liters in every week per heap or pit.

Vermicomopost Preparation under Tree shade by Pit and Heap Methods

Open permanent pits of 10 feet length 3 feet width 2 feet deep were constructed under the tree shade, which was about 2 feet above ground to avoid entry of rainwater into the pits. Brick walls were constructed above the pit floor and perforated into 10 cm diameter 5-6 holes in the pit wall for aeration. The holes in the wall were blocked with nylon screen (100 mesh) so that earthworms may not escape from the pits. Partially decomposed dung (dung about 2 month old) was spread on the bottom of the pits to a thickness of about 3-4cm. This was followed by addition of layer of litter/ residue and dung in the ratio of 1:1 (w/w). A second layer of dung was then applied followed by another layer of litter/crop residue in the same ratio up to a height of 2 feet. Two species of epigeic earthworms viz., *Eisenia foetida* and *Perionyx excavatus* were inoculated in the pit. Moisture content was maintained at 60-70% throughout the decomposition period. Jute bags (gunny bags) were spread uniformly on the surface of the materials to facilitate maintenance of suitable moisture regime and temperature conditions.

Watering by sprinkler was often done. The materials were allowed to decompose for 15-20 days to stabilize the temperature to reach the mesophilic stage, the process has to pass the thermophilic stage, which comes in about 3 weeks. Earthworms were inoculated in the pit or heap with 10 adult earthworms per kg of waste material and a total of 500 worms were added to each pit or heap. The materials were allowed to decompose for 110 days. The forest litter was decomposed much earlier (75 to 85 days) than farm residue (110-115 days). In the heap method the waste materials and partially decomposed dung (1:1 w/w) are made in heaps of dimension; 10 feet length x 3 feet width x 2 feet high and during inoculation channels are made by hand and earthworm @ 1 kg per quintal of waste are inoculated and then watering is done by sprinkler method. Jute cloth pieces are used as covering material.

Suitable species for vermicomposting

There are different species of earthworms viz. *Eisenia foetida* (Red earthworm), *Eudrilus eugeniae* (night crawler), *Perionyx excavatus* etc.

Red earthworm is preferred because of its high multiplication rate and thereby converts the organic matter into vermicompost within 45-50 days. Since it is a surface feeder it converts organic materials into vermicompost from top.

Desirable attributes of worms suitable for vermicomposting

1. Worm should exhibit high biomass consumption together with a high efficiency of conversion of ingested biomass to body proteins, a physiological trait required for achieving high growth rate.
2. Worm should have wider range of tolerance to environmental factors including adaptation to feed on a variety of organic residues.
3. Worm should produce large numbers of cocoons with short hatching time enabling rapid population growth and, linked to this rapid growth, faster composting of organic residues.
4. Life cycle of the worm should be such that mature/ adult phase is quickly reached.
5. Using a mixture of species is likely to be more useful than use of single species.
6. Worm should be disease resistant.

Vermicomposting process: It is an aerobic, bio-oxidation, non-thermophilic process of organic waste decomposition that depends upon earthworms to fragment, mix and promote microbial activity.

The basic requirements during the process of vermicomposting are

- Suitable bedding
- Food source
- Adequate moisture
- Adequate aeration
- Suitable temperature
- Suitable pH

Bedding: Bedding is any material that provides a relatively stable habitat to worms. For good vermicomposting, this habitat should satisfy the following criteria:

- High absorbency: As worms breathe through skin, the bedding must be able to absorb and retain adequate water
- Good bulking potential: The bulking potential of the material should be such that worms get oxygen properly.
- Low nitrogen content (high Carbon: Nitrogen ratio): Although worms consume their bedding as it breaks down, it is very important that this be a slow process. High protein/nitrogen levels can result in rapid degradation and associated heating may be fatal to worms.

Food Source: Regular input of feed materials for the earthworms is most essential step in the vermicomposting process. Earthworms can use a wide variety of organic materials as food but do exhibit food preferences. In adverse conditions, earthworms can extract sufficient nourishment from soil to survive. However earthworms feed mainly on dead and decaying organic waste and on free living soil microflora and fauna. Under ideal conditions, worms can consume amount of food higher than their body weights, the general rule-of-thumb is consumption of food weighing half of their body weight per day. Live stock excreta, viz., goat manure, cattle dung or pig manure are the most commonly used worm feed stock as these materials have higher nitrogen content. When the material with higher carbon content is used with C: N ratio exceeding 40: 1, it is advisable to add nitrogen supplements to ensure effective decomposition. The food should be added only as a limited layer as an excess of the waste many generate heat. From the waste ingested by the worms, 5-10% are being assimilated in their body and the rest are being excreted in the form of vermicast.

Moisture: Perhaps the most important requirement of earthworms is adequate moisture. They require moisture in the range of 60-70%. The feed stock should not be too wet otherwise it may create anaerobic conditions which may be fatal to earthworms.

Aeration: Factors such as high levels of fatty/oily substances in the feed stock or or excessive moisture combined with poor aeration may render anaerobic conditions in vermicomposting system. Worms suffer severe mortality partly because they are deprived of oxygen and partly because of toxic substances (e.g. ammonia) produced under such conditions. This is one of the main reasons for not including meat or other fatty/oily wastes in worm feed stock unless they have been pre-composted to break down the oils and fats.

Temperature: The activity, metabolism, growth, respiration and reproduction of earthworms are greatly influenced by temperature. Most earthworm species used in vermicomposting require moderate temperatures from 10 – 35^{o} C. While tolerances and preferences vary from species to species. Earthworms can tolerate cold and moist conditions far better than hot and dry conditions. For *Eisenia foetida* temperatures above 10^{o}C (minimum) and preferably 15^{o}C are maintained for maximizing vermicomposting efficiency and above 15^{o}C (minimum) and preferably 20^{o}C for vermiculture. Higher temperatures (> 35^{o} C) may result in high mortality. Worms will redistribute themselves within piles, beds or windrows such that they get favorable temperatures in the bed.

pH: Worms can survive in a pH range of 5 to 9, but a range of 7.5 to 8.0 is considered to be the optimum. In general, the pH of worm beds tends to drop over time due to the fragmentation of organic matter under series of chemical reactions. Thus, if the food sources are alkaline, the effect is a moderating one, tending to neutral or slightly acidic, and if acidic (e.g., coffee grounds, peat moss); pH of the beds can drop well below 7. In such acidic conditions, pests like mites may become abundant. The pH can be adjusted upwards by adding calcium carbonate.

Other Important Parameters: There are a number of other parameters of importance to vermicomposting:

Pre-composting of organic waste: Scientists reported the death of *Eisenia foetida* after 2 weeks in the fresh cattle solids although all other growth parameters such as moisture content, pH, electrical conductivity, C: N ratio, NH_4 and NO_3- contents were suitable for the growth of

the earthworms.They attributed the deaths of earthworms to the anaerobic conditions which developed after 2 weeks in fresh cattle solids. It is established that pre-composting of organic waste is very essential to avoid the mortality of worms.

Salt content: Worms are very sensitive to salts, preferring salt contents less than 0.5% in feed.

Urine content: According to Gaddie and Douglas if the manure is from animals raised or fed off in concrete lots, it will contain excessive urine because the urine cannot drain off into the ground. This manure should be leached before use to remove the urine. Excessive urine will build up toxic gases like ammonia in the bedding.

Other toxic components: Different feeds can contain a wide variety of potentially toxic components.

- Detergent cleansers industrial chemicals, pesticides: These can often be found in feeds such as sewage or septic sludge, paper-mill sludge, or some food processing wastes.
- Tannins: Some trees, such as cedar and fir, have high levels of these naturally occurring substances. They can harm worms and even drive them away from the beds. It has been pointed out that pre-composting of wastes can reduce or even eliminate most of these threats. However, pre-composting also reduces the nutrient value of the feed.

Pests and Diseases: Moles prey on earthworms and hence are often a problem when using windrows or other open-air vermicomposting systems. Damage due to rats and moles can be prevented by putting some form of barrier, such as wire mesh, paving, or a good layer of clay, under the windrow. Putting some type of windrow cover (e.g., old gunny bags) over the material will eliminate damage to worms by birds, apart from improving moisture retention and excessive leaching likely during high rainfall events. Centipedes eat compost worms and their cocoons. Fortunately, they do not seem to multiply to a great extent within worm beds or windrows. If they do become a problem, one method suggested for reducing their numbers is to heavily wet (but not quite flood) the worm beds. The water forces centipedes and other insect pests (but not the worms) to the surface, where they can be destroyed by means of a hand-held propane torch. Ants are more of a problem because they consume the feed meant for the worms. This problem can be checked by avoiding sweet feeds in the worm beds and maintaining a pH of 7 or slightly higher. White and brown mites compete with worms for

food and can thus have some economic impact, but red mites are parasitic on earthworms. They suck blood or body fluid from worms and they can also suck fluid from cocoons. The best prevention for red mites is to make sure that the pH of the bedding is neutral or slightly alkaline. This can be done by keeping the moisture levels below 85% and through the addition of calcium carbonate, as required.

Sour crop or protein poisoning happens when worms are overfed leading to protein build up in the bedding and production of toxic acids and gases due to protein decay. The better option is to maintain proper feed quality and micro environmental conditions which rule out any possibility of sour crop.

Nutrients in Vermicompost

It has been estimated that earthworms add 230 kg N/ ha/ year in grasslands and 165 kg N/ha/year in woodland sites. Earthworms increase the nitrate production by stimulating bacterial activity and through their own decomposition. There are reports that concentrations of exchangeable cations such as Ca, Mg, Na, K, available P and Mo in the worm casts are higher than those in the surrounding soil. Vermicompost can not be described as being nutritionally superior to other organic manures. Instead, it is a unique way of manure production.

Chemical composition of worm cast:

Organic carbon%	——	9.15 to 17.88
Total Nitrogen %	——	0.5 to 0.9
Phosphorus %	——	0.1 to 0.26
Potassium %	——	0.15 to 0.256
Sodium %	——	0.055 to 0.3
Calcium & magnesium (Meq/100 g)	——	22.67 to 47.6
Copper (mg L-1)	——	2.0 to 9.5
Iron (mg L-1)	——	2.0 to 9.3
Zinc (mg L-1)	——	5.7 to 9.3
Sulphur (mg L-1)	——	128.0 to 548.0

As a processing system, the vermicomposting of organic waste is very simple. Worms ingest the waste material – break it up in their rudimentary gizzards – consume the digestible/putrefiable portion, and then excrete a stable, humus-like material that can be immediately marketed and has a variety of documented benefits to the consumer. Vermitechnology can be a promising technique that has shown its potential in certain challenging areas like augmentation of food production, waste recycling, management of solid wastes etc. There is no doubt that in India, where on side pollution is increasing due to accumulation of organic wastes and on the other side there is shortage of organic manure, which could increase the fertility and productivity of the land and produce nutritive and safe food. So the scope for vermicomposting is enormous.

HONEY BEE – APICULTURE

Classification

Phylum: Arthropoda; Class: Insecta; Order: Hymenoptera; Family: Apidae; Genus: *Apis;* Species: *mellifera*

Introduction

Maintenance of honey bee colonies commonly in hives is known as apiculture. A bee keeper known as apiarist, keeps bees in order to collect honey and other products of the hive which includes **bee-wax**, **propolis**, pollen,**royal jelly** to pollinate crops and to produce beesfor sale to other bee keepers. The location where bees are kept is called an **apiry** or bee-yard.

The term Apiculture is derived from the generic name of western honey bee or European honey bee (*Apis mellifera*). The genus ***Apis*** is a Latin word for "bee"and ***mellifera*** from Latin *melli*-"honey" and *ferre* "to bear", hence, the scientific name means "honey-bearing bee". This name was recoined as ***Apis mellifica*** (honey-making bee) by Carlous Linnaeus, after realizing the difference as bees do not bear honey. Bee keeping is an agro based enterprise, which farmers can take up for additional income generation.

Advantages of bee keeping as an income generation activity

- Bee keeping requires less time, money and infrastructure investments
- Honey and bee wax can be produced from an area of little agricultural value
- The Honey bee does not compete for resources with any other agricultural enterprise.
- Bee keeping has positive ecological consequences. Bees play an important role in the pollination of many flowering plants, thus increasing the yield of certain crops such as sunflower and various fruits.

- Honey is a delicious and highly nutritious food. By the traditional method of honey hunting many wild colonies of bees are destroyed. This can be prevented by raising bees in boxes and producing honey at home.
- Bee keeping can be initiated by individuals or groups
- The market potential for honey and wax is high

Products of Apiculture

Honey

Honey is used in cooking, baking, to spread on bread and as an additive to various beverages, such as Tea. Honey is the main ingredient in the alcohol beverage, which is known as Honey Wine OR Honey Beer. It acts as an antimicrobial agent with potential for treating a variety of ailments, as antibacterial with the properties of lowering water activity by causing osmosis,and for chelation of free ions. Honey appears to be effective in killing drug-resistant biofilms which are implicated in chronic rhino sinusitis. Topical honey has been used successfully in a comprehensive treatment of diabetic ulcers when the patient cannot use topical antibiotics. Honey has also been used for centuries as a treatment for sore throats and coughs as an effective soothing agent. Honey is used in the preparation of Face pack and in other cosmetics.

Chemical Composition of Honey

Honey is rich in Carbohydrates and different types of sugars like Fructose, Glucose and Sucrose. It containsVitamins of B-series (Riboflavin B2, Niacin B3, Pantothenic acid B5), B6, Folate B9 and Vitamin C and also contains different essential metal ions such as Calcium, Iron, Magnesium, Sodium, Potassium and Zinc. Doesn't contain Fat but contains proteins and fibers. 100 ml of honey generates about 304 kcal of energy.

Synthesis of Honey

Honey is synthesized from nectar by honey bees. The bees transform nectar by a process known as Regurgitation and store in hives. The nectar is processed by digestive enzymes in the honey stomach of bees to ingest and regurgitate until it is partially digested. The honey is made concentrated to evaporate water by fanning of bees. Evaporation of water prevents fermentation and increases sugar concentration.